0 layer SERIES

Maximum Power Point Tracking Solar Charge Controller

MPPT 60A

User Manual(Continuously updated version)

Some information in this version User Manual can not be found in paper manual.
For easier and clearer use of the controller We will continue to improve this manual,
Any questions/suggestions/feedback, welcome contact us !



⚠ Important Safety Instructions ⚠

Please save these instructions.

This manual contains important safety, installation, and operating instructions for the charge controller. The following symbols are used throughout the manual to indicate potentially dangerous conditions or important safety information.

WARNING	Indicates a potentially dangerous condition. Use extreme caution when performing this task
CAUTION	Indicates a critical procedure for safe and proper operation of the controller
NOTE	Indicates a procedure or function that is important to the safe and proper operation of the controller

General Safety Information

- Read all of the instructions and cautions in the manual before beginning the installation.
- There are no serviceable parts for this controller. Do **NOT** disassemble or attempt to repair the controller.
- Do **NOT** allow water to enter the controller.
- Make sure all connections going into and from the controller are tight.

Charge Controller Safety

- **NEVER** connect the solar panel array to the controller without a battery. Battery must be connected first.
- Ensure input voltage does not exceed 190 VDC to prevent permanent damage. Use the Open Circuit Voltage (Voc) to make sure the voltage does not exceed this value when connecting panels together.

Battery Safety

- Use only sealed lead-acid, flooded, gel or lithium batteries which **must be deep cycle.**
- Explosive battery gases may be present while charging. Be certain there is enough ventilation to release the gases.
- Be careful when working with large lead acid batteries. Wear eye protection and have fresh water available in case there is contact with the battery acid.
- Carefully read battery manuals before operation.
- Do **NOT** let the positive (+) and negative (-) terminals of the battery touch each other.
- Recycle battery when it is replaced.
- Over-charging and excessive gas precipitation may damage the battery plates and activate material shedding on them. Too high of an equalizing charge or too long of one may cause damage. Please carefully review the specific requirements of the battery used in the system.
- Equalization is carried out only for non-sealed / vented/ flooded / wet cell lead acid batteries.
- Do **NOT** equalize VRLA type AGM / Gel / Lithium cell batteries UNLESS permitted by battery manufacturer.

WARNING

Connect battery terminals to the charge controller BEFORE connecting the solar panel(s) to the charge controller. NEVER connect solar panels to charge controller until the battery is connected.

Do NOT connect any inverters or battery charger into the load terminal of the charge controller.

Once equalization is active in the battery charging, it will not exit this stage unless there is adequate charging current from the solar panel. There should be NO load on the batteries when in equalization charging stage.

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General Information

The 0 layer Series charge controllers are intelligent controllers suitable for various off-grid solar applications. It protects the battery from being over-charged by the solar modules and over-discharged by the loads. The controller features a smart tracking algorithm that maximizes the energy from the solar PV module(s) and charge the battery. At the same time, the low voltage disconnect function (LVD) will prevent the battery from over discharging.

The 0 layer's charging process has been optimized for long battery life and improved system performance. The comprehensive self-diagnostics and electronic protection functions can prevent damage from installation mistakes or system faults.

Key Features

- Automatically detect 12V/24V/36V/48V DC system voltages
- Innovative MPPT technology with high tracking efficiency up to 99% and peak conversion efficiency of 98%
- Deep cycle Sealed, Gel, Flooded and Lithium battery option ready
- Electronic protection: Overcharging, over-discharging, overload, and short circuit
- Reverse protection: Any combination of solar module and battery, without causing damage to any component
- Customizable charging voltages

MPPT Technology

The MPPT Charge Controller utilizes Maximum Power Point Tracking technology to extract maximum power from the solar module(s). The tracking algorithm is fully automatic and does not require user adjustment. MPPT technology will track the array's maximum power point voltage (Vmp) as it varies with weather conditions, ensuring that the maximum power is harvested from the array throughout the course of the day.

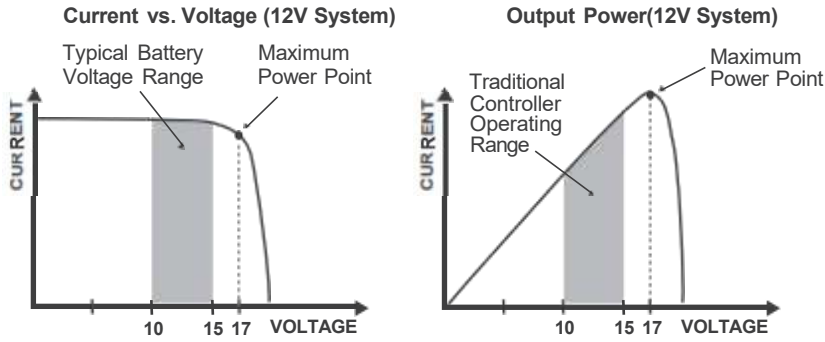
Current Boost

In many cases, the MPPT charge controller will "boost" up the current in the solar system. The current does not come out of thin air. Instead, the power generated in the solar panels is the same power that is transmitted into the battery bank. Power is the product of Voltage (V) x Amperage (A).

Therefore, assuming 100% efficiency:

Power In = Power Out
Volts In * Amps n = Volts out * Amps out

Although MPPT controllers are not 100% efficient, they are very close at about 92-95% efficient. Therefore, when the user has a solar system whose Vmp is greater than the battery bank voltage, then that potential difference is proportional to the current boost. The voltage generated at the solar module needs to be stepped down to a rate that could charge the battery in a stable fashion by which the amperage is boosted accordingly to the drop. It is entirely possible to have a solar module generate 8 amps going into the charge controller and likewise have the charge controller send 10 amps to the battery bank. This is the essence of the MPPT charge controllers and their advantage over traditional charge controllers. In traditional charge controllers, that stepped down voltage amount is wasted because the controller algorithm can only dissipate it as heat. The following demonstrates a graphical point regarding the output of MPPT technology.

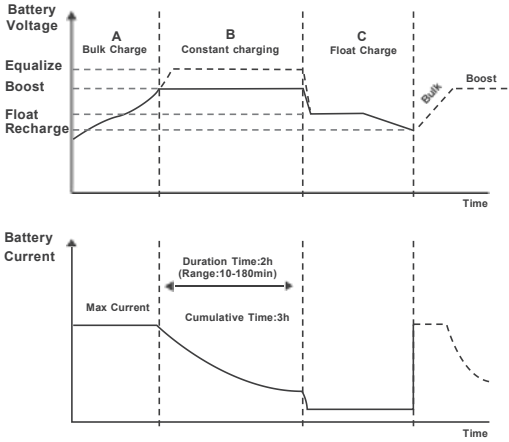


Limiting Effectiveness

Temperature is a huge enemy of solar modules. As the environmental temperature increases, the operating voltage (Vmp) is reduced and limits the power generation of the solar module. Despite the effectiveness of MPPT technology, the charging algorithm will possibly not have much to work with and therefore there is an inevitable decrease in performance. In this scenario, it would be preferred to have modules with higher nominal voltage, so that despite the drop in performance of the panel, the battery is still receiving a current boost because of the proportional drop in module voltage.

Four Charging Stages

The 0 layer MPPT charge controller has a 4-stage battery charging algorithm for a rapid, efficient , and safe battery charging. They include: Bulk Charge, Boost Charge, Float Charge, and Equalization.



Bulk Charge: This algorithm is used for day to day charging. It uses 100% of available solar power to recharge the battery and is equivalent to constant current. In this stage the battery voltage has not yet reached constant voltage (Equalize or Boost), the controller operates in constant current mode, delivering its maximum current to the batteries (MPPT Charging) .

Constant Charging: When the battery reaches the constant voltage set point, the controller will start to operate in constant charging mode, where it is no longer MPPT charging. The current will drop gradually. This has two stages, equalize and boost and they are not carried out constantly in a full charge process to avoid too much gas precipitation or overheating of the battery.

- **Boost Charge:** Boost stage maintains a charge for 2 hours by default. The user can adjust the constant time and preset value of boost per their demand.

Float Charge: After the constant voltage stage, the controller will reduce the battery voltage to a float voltage set point. Once the battery is fully charged, there will be no more chemical reactions and all the charge current would turn into heat or gas. Because of this,

The charge controller will reduce the voltage charge to smaller quantity, while lightly charging the battery. The purpose for this is to offset the power consumption while maintaining a full battery storage capacity. In the event that a load drawn from the battery exceeds the charge current, the controller will no longer be able to maintain the battery to a Float set point and the controller will end the float charge stage and refer back to bulk charging.

⚠ **Equalization:** Is carried out every 28 days of the month. It is intentional overcharging of the battery for a controlled period of time. Certain types of batteries benefit from periodic equalizing charge, which can stir the electrolyte, balance battery voltage and complete chemical reaction. Equalizing charge increases the battery voltage, higher than the standard complement voltage, which gasifies the battery electrolyte.

WARNING Once equalization is active in the battery charging, it will not exit this stage unless there is adequate charging current from the solar panel. There should be NO load on the batteries when in equalization charging stage.

WARNING Over-charging and excessive gas precipitation may damage the battery plates and activate material shedding on them. Too high of equalizing charge or for too long may cause damage. Please carefully review the specific requirements of the battery used in the system.

WARNING Equalization may increase battery voltage to a level damaging to sensitive DC loads. Ensure that all load allowable input voltages are greater than the equalizing charging set point voltage.

Lithium Battery Activation

The 0 layer MPPT charge controller has a reactivation feature to awaken a sleeping lithium battery. The protection circuit of lithium battery will typically turn the battery off and make it unusable if over-discharged. This can happen when storing a lithium battery pack in a discharged state for any length of time as self-discharge would gradually deplete the remaining charge. Without the wake-up feature to reactivate and recharge batteries, these batteries would become unserviceable and the packs would be discarded. The 0 layer will apply a small charge current to activate the protection circuit and if a correct cell voltage can be reached, it starts a normal charge.

Identification of Parts



Key Parts

1. Display Screen	7. Solar panel “+” Interface
2. PV Parameters	8. Solar panel “-” Interface
3. Battery Parameters	9. Battery “+” Interface
4. Load Parameters	10.Battery “-” Interface
5. Save/Restore	11.Load “+” Interface
6. Installation Hole	12.Load “-” Interface

Mounting Recommendations

WARNING

NEVER install the controller in a sealed enclosure with flooded batteries. Gas can accumulate and there is a risk of explosion.

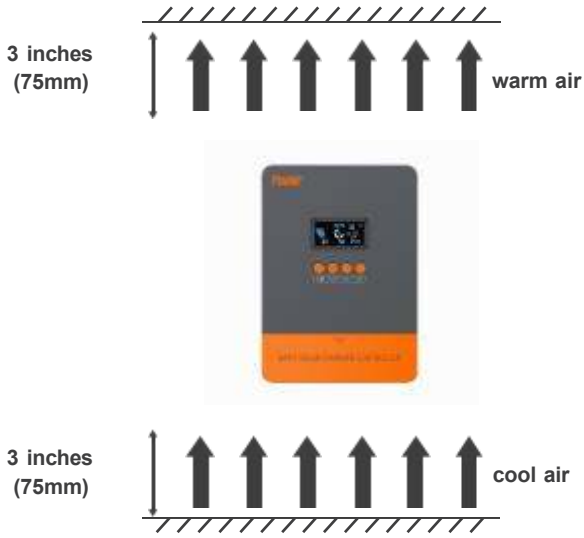
1. Choose Mounting Location—place the controller on a vertical surface protected from direct sunlight, high temperatures, and water. Make sure there is good ventilation.

2. Check for Clearance—verify that there is sufficient room to run wires, as well as clearance above and below the controller for ventilation. The clearance should be at least 3 inches (75mm).

3. Mark Holes

4. Drill Holes

5. Secure the charge controller.



Mounting Recommendations

The controller can be mounted using the existing mounting holes or using the included mounting brackets.

Recommended solar panel configuration

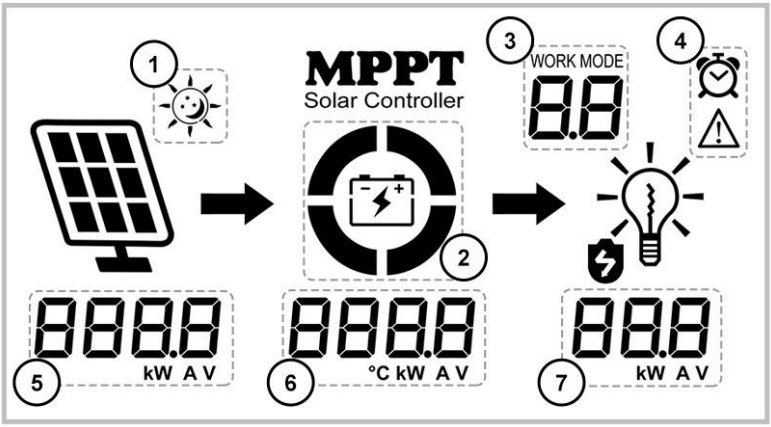
	12V battery	24V battery	36V battery	48V battery
Max Solar power	720W	1440W	2100W	2800W
Solar voltage range	20Vdc~80Vdc	37Vdc~105Vdc	50Vdc~150Vdc	72Vdc~150Vdc
**For safety please connect the battery solar panel within the recommended range				

Tips: When battery connected, Controller will Automatically detect 12V/24V/36V/48V DC system voltages, but you still need choose your battery tpye. If you find the pre-set battery type's charging voltage doesn't match your battery, please choose battery type as "User" to set your own charging parameter.

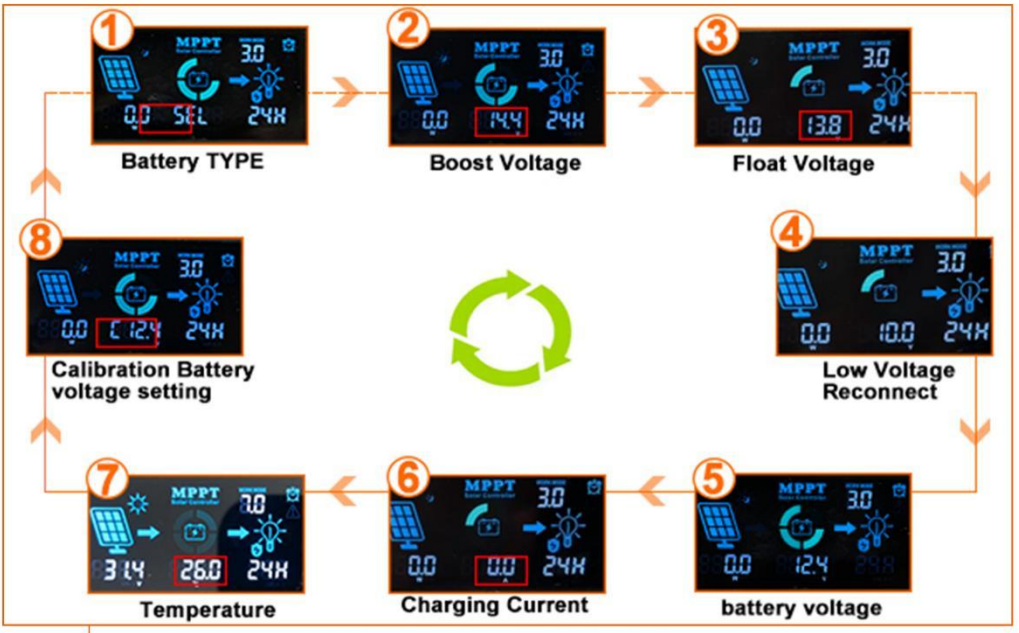
Operation

0 layer is very simple to use. Simply connect the batteries, and the controller will automatically determine the battery voltage. The controller comes equipped with an LCD screen and 4 buttons to maneuver though the menus.

PV	Page PV
BAT/▲	Page(BAT) Up/ Increase parameter value
DC/▼	Page(DC) Down/ Decrease parameter value
SET/	Save/Restore



1 Day or night indicating icon	2 Battery icon and SOC
3 Work Mode	4 State and Warming indication
5 Solar panel voltage/power/current	6 Charging power/Charging current Battery voltage
7 Load working Mode / Load power / Load current / Load voltage	


1
Battery TYPE
2
Boost Voltage
3
Float Voltage
4
Low Voltage Reconnect
5
battery voltage
6
Charging Current
7
Temperature
8
Calibration Battery voltage setting


PowMr
PV/
BAT/
DC/
SET/
MPPT Solar Charge Controller

Button Operation



PV button

Press "PV/" to browse PV voltage and PV current
(*PV button is only for viewing parameters, no setting function)



Batt/up button

Function 1: when display show battery type C-voltage, Press and hold " BAT/▲ " until the value flashes, then press " BAT/▲ " " DC/▼ " button to adjust value, press " SET/ " to confirm and save.



(Figure2-1 Battery type)



(Figure2-2 constant charge voltage)

Function 2: Press " BAT/▲ " to Browse Controller parameters.
(*Only battery type and constant charge voltage can be set, other parameters can be viewed by pressing the button)



DC/down button

Function 1: 【Load mode setting】Press and hold DC/▼ until value flash, then enter 【Load mode setting】.

****Load Mode Instruation****

-00H: Load Turn OFF

-24H: Load always Turn ON

-01H~23H: Time control（Set load ON's duration）

Function 2: When controller in setting mode press " DC/▼ " to adjust the value.



SET button

Function 1: When controller in setting mode, press " SET/ " to save parameters

Function 2: 【Reset Controller】Press and hold until All parameters on the screen flash.

0 layer **Protections**

PV Array Short Circuit	When PV short circuit occurs, the controller will stop charging. Clear it to resume normal operation.
PV Overcurrent	The controller will limit the battery charging current to the maximum battery current rating. Therefore, an over-sized solar array will not operate at peak power.
Load Overload	If the current exceeds the maximum load current rating of 21A, the controller will disconnect the load. Overloading must be cleared up by reducing the load and restarting the controller.
Load Short Circuit	Fully protected against the load wiring short-circuit. Once the load short (more than quadruple rate current), the load short protection will start automatically. After 5 automatic load reconnect attempts, the faults must be cleared by restarting the controller.
PV Reverse Polarity	The controller will not operate if the PV wires are switched. Wire them correctly to resume normal controller operation.
Battery Reverse Polarity	The controller will not operate if the battery wires are switched. Wire them correctly to resume normal controller operation.
Over-Temperature	If the temperature of the controller heat sink exceeds 65℃, the controller will automatically start reducing the charging current and shut down when temperature exceeds 80℃.

Fusing

Fusing is a recommended in PV systems to provide a safety measure for connections going from panel to controller and controller to battery. Remember to always use the recommended wire gauge size based on the PV system and the controller.

NEC Maximum Current for different Copper Wire Sizes									
AWG	16	14	12	10	8	6	4	2	0
Max. Current	18A	25A	30A	40A	55A	75A	95A	130A	170A

The NEC code requires the overcurrent protection shall not exceed 15A for 14AWG, 20A for 12 AWG, and 30A for 10AWG copper wire.

Fuse from Controller to Battery

NOTE

Controller to Battery Fuse = Current Rating of Charge Controller
Ex. 20A MPPT CC = 20A fuse from Controller to Battery

Fuse from Solar Panel(s) to Controller

Ex. 200W; 2 X 100 W panels

****Utilize 1.56 Sizing Factor (SF)**

NOTE **Different safety factors could be used. The purpose is to oversize.**

Series:	**Parallel**
Total Amperage= Isc1 = Isc2 * SF = 5.75A * 1.56 = 8.97 **Fuse** = **9A fuse**	**Total Amperage**= (Isc1 + Isc2) * SF =(5.75A + 5.75A)* 1.56 = 17.94 **Fuse = 18A fuse**

Technical Specifications

Electrical Parameters

Model	POW-M60-PRO
Nominal system voltage	12V/24V/36V/48V Auto Recognition
Rated Battery Current	60A
Rated Load Current	6A
Max. capacitive load capacity	10000μF
Battery Voltage	9V - 70V
Max Solar Input Voltage	190 VDC (25°C), When working max 160Vdc
Max. power point voltage range	Battery voltage +2V to 120V
Max. Solar Input Power	720W/12V;1440W/24V;2100W/36V;2800W/48V
Self-Consumption	0.7W - 1.2W
Conversion efficiency	≤ 98%
MPPT tracking efficiency	> 99%
Temp. Compensation	-3mV/°C/2V (default)

General

Model	POW-M60-PRO
Dimensions	230 x 165 x 72mm (9.1 x 6.5 x 2.8in)
Mounting Holes	16mm²(5AWG) suggestion:8AWG(10mm²)-5AWG(16mm²)
Max Terminal Size	25mm² 4 AWG
Net Weight	1.33 kg 2.9 lbs
Working Temperature	-35°C to +45°C
Humidity Range	≤ 95% (NC)
Enclosure	IP32
Altitude	< 3000m

Battery Charging Parameters

Battery	GEL	SEALED	FLOODED	LI (LFP)	USER
Boost Voltage	14.2 V	14.4 V	14.6 V	14.4 V	13.9-18V
Float Voltage	13.8 V	13.8 V	13.8 V	-----	12.5-14.4V
Low Voltage Reconnect	10 V	10 V	10 V	10 V	8-12.3V

1. Default charging parameters in LI mode are programmed for 12.8V LFP battery. Before using M60 to charge other lithium battery, set the charging parameters according to the suggestions from battery manufacturer.

2. The above parameters are based on 12V system settings. Parameters are multiplied by 2 for 24V systems, multiplied by 3 for 36V systems, and multiplied by 4 for 48V systems.

When selecting User, the battery type is to be self-customized, and in this case, the default system voltage parameters are consistent with those of the sealed lead-acid battery. When modifying battery charging and discharging parameters, the following rule must be followed:

- Over-voltage cut-off voltage > Charging limit voltage ≥ Equalizing voltage ≥ Boost voltage ≥ Floating charging voltage > Boost recovery voltage;
- Over-voltage cut-off voltage > Over-voltage cut-off recovery voltage;
- Low-voltage cut-off recovery voltage > Low-voltage cut-off voltage ≥ Discharging limit voltage;
- Under-voltage warning recovery voltage > Under-voltage warning voltage ≥ Discharging limit voltage;
- Boost recovery voltage > Low-voltage cut-off recovery voltage

PV Power – Conversion Efficiency Curves

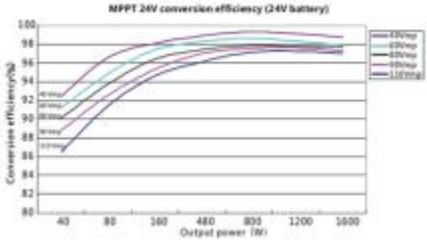
Illumination Intensity: 1000W/ m²

Temp 25℃

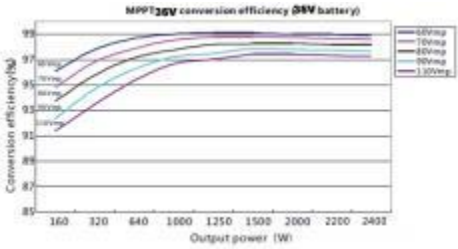
1.12 Volt System Conversion Efficiency



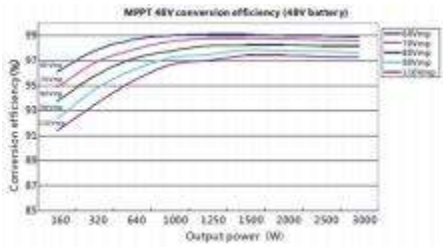
2. 24 Volt System Conversion Efficiency



3. 36 Volt System Conversion Efficiency



4. 48 Volt System Conversion Efficiency



Work Mode list

Working Mode	Description
3.0	Night mode, no charging
4.0	MPPT Charge mode
7.0	Absorption Charge mode
8.0	Floating Charge mode
18	Input PV voltage is low，please Increase the PV voltage
60	Over temperature protection
63	Protection-Battery voltage is high，Battery high voltage protection and wait for recovery
65	Battery voltage is low，Battery over discharge and wait for recovery
71	Input PV voltage is high，please Decrease the PV voltage
73	Over charging current，please Decrease the PV power

NOTE: This User Manual is Continuously update version

PV button

View PV voltage/PV current

(*PV button is only for viewing parameters)

Batt/up button

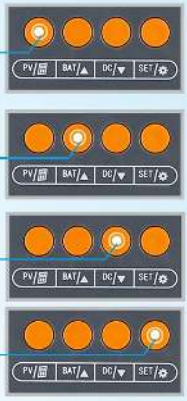
View Battery info, adjust value
Set battery type.

DC/down button

Load mode setting

SET button

save/reset parameters





WORKING MODE

3.0——Night mode, no charging

4.0——MPPT Charge mode

7.0——Absorption Charge mode

8.0——Floating Charge mode

18 60 63 65 71 73——Error code

LOAD MODE

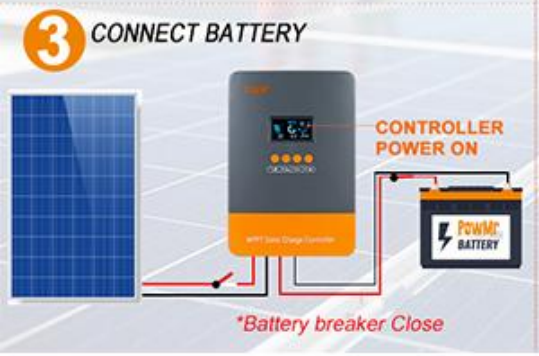
00H——Load Turn OFF

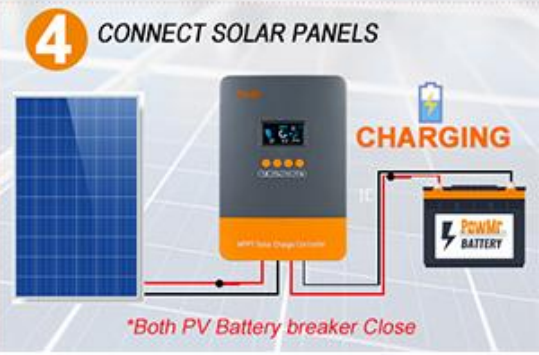
24H——Load always Turn ON

01H~23H——Time control
(Set load ON's duration)









EASY INSTALLTION